Effect of compost amendment and compaction on the fate and ecotoxicological impact of isoproturon in soil

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❖ Introduction

Organic matter decline and compaction are two major related soil degradation processes [1]. Compaction changes the physical properties of soils (porosity, air content…) with consequences on their biological functioning. Compost amendment is a current practice to compensate the loss of organic matter, which could contribute to increase soil aggregate stability and to limit compaction. Furthermore, composts also modify the biological and chemical properties of soils. Therefore, both compost addition and compaction could affect the fate and impact of pesticides in soils, however this is poorly documented.

❖ Objective

The objective of this work was to study the effect of compost amendment and soil compaction on the fate and ecotoxicological impact (measured through two enzyme activities) of isoproturon (one of the most used herbicide for cereals in Europe).

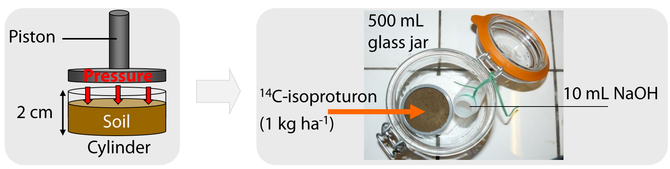
❖ Materials & Methods

Undisturbed soil cores (5 × 2 cm) were sampled in the interfurrows of 2 plots (silt loam soil):

- Control plot (no compost)
- Plot receiving a co-compost of sewage sludge and green waste every other year (seventh application 12 months before sampling)

Table 1. Main soil characteristics

Soil	pH (water)	Organic carbon (%)	Density (g cm^{-3}) No compaction	Density (g cm^{-3}) High compaction
Control	6.75	1.19	1.30 ± 0.1	1.60 ± 0.1
Compost amended	6.76	1.41	1.15 ± 0.1	1.45 ± 0.1



- Soil cores were prepared at two levels of compaction (Table 1)
- They were treated with ^{14}C-isoproturon and incubated at 28°C in darkness for 60 d
- Each jar contained vials with NaOH to trap the $^{14}CO_2$, and with water to maintain a constant relative humidity
- Five replicates were done for each soil, compaction, treatment, and sampling date

Fate of isoproturon

- Mineralization kinetics
- Soil extraction with $CaCl_2$ then CH_3OH (0-7-49 d)
- Non-extractable residues (0-7-49 d)

→ Liquid scintillation counting

β-glucosidase and urease activities

- Addition of substrates to soil samples → Quantitative determination of the reaction product with spectrophotometer (0-7-60 d)

❖ Results & Discussion

Fate of isoproturon in amended and not amended soils, compacted or not

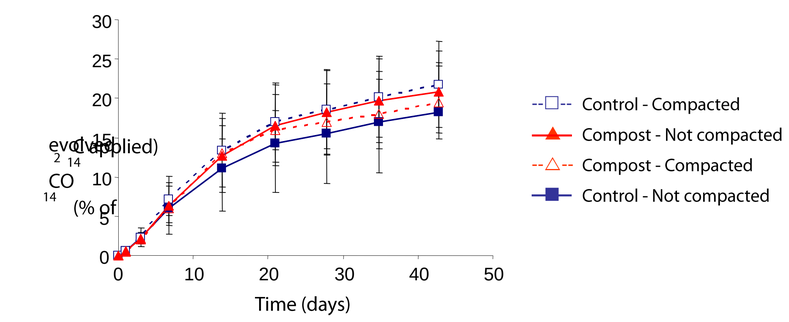


Figure 1. Mineralization kinetics of isoproturon in amended or not amended soil, compacted or not compacted

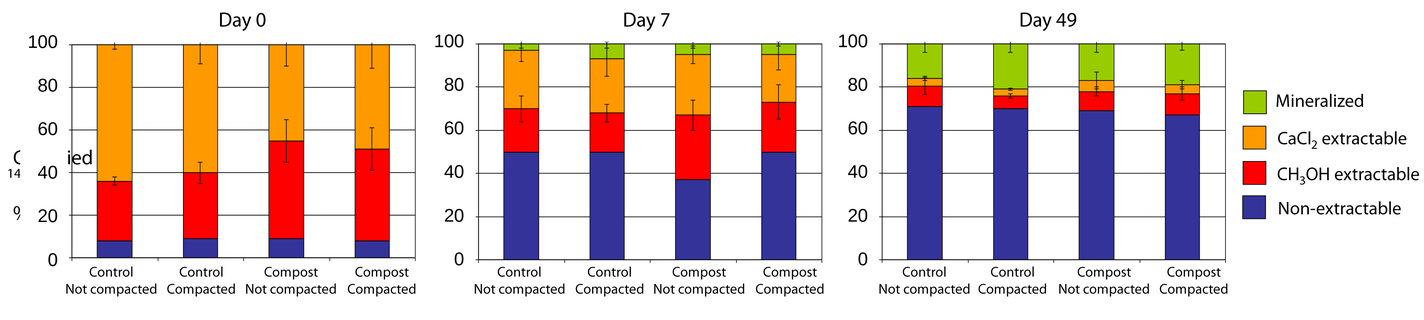


Figure 2. Overall balance of ^{14}C after 0, 7 and 49 days of incubation in amended or not amended soil, compacted or not compacted

- The mineralization of isoproturon reached a maximum of 20% (Fig. 1). The main dissipation pathway was the formation of non-extractable residues (Fig. 2)
- Compaction had no effect on the fate of isoproturon (Fig. 1 & 2) probably because the reduction in porosity did not affect the habitable pore space accessible to degrading microorganisms [2]
- The unexpected lack of effect of compost can be due to: (i) chemical characteristics of this compost [3], (ii) lack of significant change in the soil characteristics after compost addition, (iii) because the effect of compost on properties such as pesticide degrading activities vary according with the time of sampling and the delay with the last amendments [3]

Ecotoxicological impact of isoproturon in soil

Table 2. Effect of compaction and compost on the ecotoxicological impact of isoproturon measured through the β-glucosidase and urease enzyme activities

Conditions of soil incubation		β-glucosidase	Urease
Effect of isoproturon (treated / untreated)	No compost (compacted / not compacted)	ns	ns
	Compost (compacted / not compacted)	ns	ns
Effect of compost on the impact of isoproturon	Not compacted (compost / no compost)	s	ns
	Compacted (compost / no compost)	s	ns
Effect of compaction on the impact of isoproturon	No compost (compacted / not compacted)	s	ns
	Compost (compacted / not compacted)	ns	ns

s: significant (Mann-Whitney test, $P < 0.05$), ns: non significant ($P > 0.05$)

- Isoproturon had no effect on β-glucosidase and urease activities probably because of the adaptation of microorganisms after previous applications of the herbicide in the field [4]
- No significant impact of compaction and amendment on urease was observed. This can be due to incubation conditions not limiting for the biological activity or to repeated application of compost in the soil for 10 years
- β-glucosidase was significantly affected by compaction except in the soil which was amended with compost. The compost seemed to act as a buffer with regards to compaction

❖ Conclusion

The study of the coupled effect of compaction and compost addition on the fate and impact of one herbicide, isoproturon, showed that there were very few modifications compared to the not compacted and not amended soils. However further research should be performed with other composts and biological indicators (microbial biomass, fatty acids…).

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